IMAGE BASED CONGESTION DETECTION ALGORITHMS AND ITS REAL TIME IMPLEMENTATION

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by

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DEDICATION

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

...نَرْفَعُ دَرَجَاتٍ مَّن نَّشَاءُ وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ ﴿٧٦﴾ سورة يوسف

Without Allah SWT blessing and guidance, my work would never have been possible

My supervisors Assoc. Prof. Dr. Umi Kalthum binti Ngah, Prof. Dr Widad Ismail

My great family, my dearest parents, my beloved wife, my sweet daughter Dania

My brother and sisters

To those who sacrificed their lives for all of us to live peacefully

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ADC	Analogue to Digital Converter
AOG	AND-OR Graph
BSDK	Board Software Development Kit
CCTV	Closed-Circuit Television
CMYK	Cyan, Magenta, Yellow, and Key
DAC	Digital to Analogue Converter
DCM	Data Conversion Module
DDS	Direct Digital Synthesizers
DSP	Digital Signal Processing
FPGA	Field-Programmable Gate Array
FSK	Frequency-Shift Keying
GPS	Global Positioning System
GSM	Global System for Mobile communications
HSV	Hue, Saturation, and Value
MANET	Mobile Ad Hoc Network
MBDK	Model-Based Development Kit
MRF	Markov Random Filter
OD	Original Destination
OFDM	Orthogonal frequency-division multiplexing
PLL	Phase Lock Loop
PSK	Phase-Shift Keying

RF	Radio Frequency
RGB	Red, Green, and Blue
RSU	Road Side Units
SDR	Software-Defined Radio
SFF	Small Form Factor
SoC	System-on-Chip
V2I	Vehicle to Infrastructure
V2V	Vehicle-to-Vehicle
VANET	Vehicular ad hoc network
VPBE	Video Processing Back End
VPFE	Video Processing Front End
VPSS	Video Processing Subsystem
XML	Xtensible Markup Language

LIST OF PUBLICATIONS

Khdiar, A. N., Kalthum bt Ngah, U., & Ismail, W (2011). *Traffic Congestion Detection Using Modified Watershed Algorithm*. Paper presented at the 3rd postgraduate colloquium school of Electrical and Electronics Engineering. University Sains Malaysia. EEPC, 2011.

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ALGORITMA PENGESANAN KESESAKAN BERDASARKAN IMEJ DAN PELAKSANAANNYA SECARA MASA NYATA

ABSTRAK

Dalam tahun-tahun kebelakangan ini, pengurusan trafik pintar telah menempa banyak bidang-bidang baharu dan dilengkapkan dengan baharu. Salah satu bidang penting yang memberi kesan secara langsung dalam kehidupan kita ialah sistem amaran kesesakan lalu lintas iaitu satu sistem lengkap yang mampu mengesan kesesakan dan pihak-pihak berkaitan dalam keadaan berjaga-jaga bagi menjimatkan masa, bahan bakar dan tenaga manusia. Kaedah-kaedah terkini memerlukan pengetahuan sebelumnya tentang keadaan lalulintas atau diperlukan masa untuk membuahkan hasil atau satu infrastruktur yang amat besar diperlukan untuk melaksanakan sistem itu. Namun begitu, usaha yang dilaksana kan secara tiada dalam masa nyata. Kebanyakan kajian semasa berkaitan pemprosesan imej untuk implementasi sebenar telah didapati tidak begitu boleh dipercayai kerana sama ada hasilnya kurang jitu ataupun ia tidak mampu dilaksanakan secara masa nyata. Sistem yang dicadangkan bertujuan untuk mencari cara pengesanan kesesakan baru yang mempunyai kejituan tinggi dan pemprosesan secara masa nyata, ia juga bertujuan untuk menunjukkan menghantar/menerima proses untuk penghantaran imej menggunakan *Software Defined Radio*. Sistem ini menawarkan satu pengesanan lengkap dan rangkaian penggera yang menangkap satu imej keadaan jalan raya, menentukan sama ada kesesakan lalu lintas berlaku dan akhirnya melaporkan keputusan secara wayarles kepada badan-badan pengurusan trafik bertindak dan memberitahu orang ramai supaya mengelak kawasan sesak dalam masa nyata. Satu

kaedah yang boleh dipercayai dan cepat mengesan kesesakan lalu lintas lelah dicadangkan. Kaedah ini pengesanan kenderaan dengan menggunakan algoritma ciri pasangan cahaya belakang dan algoritma *Watershed* terubahsuai. Hasil keputusan daripada algoritma dihantar dan diterima secara wayarles menggunakan platform SFFSDR, termasuk penggunaan RF, FPGA, dan modul-modul DSP untuk jarak berubah-ubah. Perolehan sistem menunjukkan pengesanan dengan ketepatan 98-98.8% penggunaan masa selama 3 saat menunjukkan kesesuaiannya bagi pelaksanaan masa nyata. Sistem wayarles telah diuji menggunakan jarak berbeza-beza antara antena-antena SDR. Penerimaan kuasa, peratus kehilangan bit dan PSNR untuk imej yang diterima telah diperolehi. Keputusan yang diperolehi menunjukkan satu PSNR 35 dB untuk jarak normal antara antena-antena (20cm) SDR dan 7 dB untuk 150cm, manakala bit-bit mula terhapus menjelang jarak 200cm.

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ABSTRACT

In recent years, intelligent traffic management have included many new fields and features. One of the important fields which directly affect our life is the traffic congestion alert system i.e. a complete system which is able to detect congestion and alert concerned parties to save time, fuel and man power. Recent methods in congestion detection need prior knowledge about the road or several minutes are taken to produce results or a huge infrastructure is needed to implement the system, even then, not in real time. Most of the current studies in image processing are not reliable for real implementation because they either lack accuracy or do not work in real time. The proposed system aims to find a new congestion detection method that has high accuracy and having real time processing time, also it aims to demonstrate the transmit/receive process for image transmission using Software Defined Radio. The proposed system offers a complete detection and alert network that captures an image of the road situation, determine whether the road is congested or clear and finally report the results wirelessly to the traffic management bodies to take action and inform people to avoid the congested areas in real time. The proposed system uses a fast and reliable method to detect traffic congestions. The methodology includes vehicle detection by using backlight pairing feature algorithm and modified Watershed algorithm. The results returned by the algorithms are transmitted and received wirelessly using the SFFSDR platform, including the use of RF, FPGA, and DSP modules for variable distances. The

system shows an accuracy of detection up to 98-98.8% with time consumption of up to 3 seconds which make it feasible for real time implementation. The wireless system has been tested using different distances between SDR antennas. The received power, bit loss percentage and PSNR for the received image have been obtained, results shows a 35dB PSNR for normal distance between SDR antennas (20cm) and 7dB for 150cm, while bits are totally lost when reaching 200cm.